

Detection of lead, chromium and cobalt in meats of cattle and buffalo from retails of Mosul city

H.S. Al-Naemi¹, R.A. Al-Sanjary², R.A. Faraj³ and A. Saadi⁴

^{1,2,3}Department of Veterinary Public Health, College of Veterinary Medicine, ⁴Department of General Science, College of Basic Education, University of Mosul, Mosul, Iraq

Email: ¹ hibaalnaemi@gmail.com, ² ralsanjary61@uomosul.edu.iq, ³ ahmedsadiyahusien@gmail.com

(Received September 4, 2019; Accepted October 13, 2019; Available online August 11, 2020)

Abstract

Lead (Pb), chromium (Cr) and cobalt (Co) were investigated in 160 local and imported meat samples of cattle and buffalo collected from markets of Mosul city by using Atomic Absorption Spectrophotometer (AAS). Results reported mean concentrations of Pb and Cr in local cattle meat 0.136 and 0.0651 mg/kg, respectively significantly higher than that reported for Co 0.008 mg/kg. In imported cattle meat, results revealed that Pb presented a mean concentration 0.182 mg/kg significantly higher than that presented by Cr and Co 0.0486 and 0.00971 mg/kg, respectively. No significant differences in the mean concentrations of Pb, Cr and Co in local buffalo meat 0.119, 0.0896 and 0.017 mg/kg, respectively, and imported buffalo meat 0.106, 0.102 and 0.041 mg/kg, respectively, were reported. The results revealed that 20% from each local cattle and buffalo meat samples, 12.5% from imported cattle meat and 22.5% from imported buffalo meat were exceeded the maximum permissible limit for lead in meat. Concerning Cr, 2.5% from imported cattle meat and 5% from each of local and imported buffalo meat surpassed the maximum acceptable limit. Ultimately, results showed that all samples of local and imported cattle and buffalo meat were within the maximum allowable limits for Co. The hazards of metals on public health was discussed.

Keywords: Lead, Chromium, Cobalt, Cattle meat, Buffalo meat

DOI: [10.33899/ijvs.2019.126069.1224](https://doi.org/10.33899/ijvs.2019.126069.1224), ©2020, College of Veterinary Medicine, University of Mosul.

This is an open access article under the CC BY 4.0 license (<http://creativecommons.org/licenses/by/4.0/>).

الكشف عن الرصاص والكروم والكوبلت في لحوم الأبقار والجاموس من أسواق مدينة الموصل

هبة صلاح الدين النعيمي^١، رعد عبد الغني السنجاري^١، رنا عوني فرج^١ و أحمد سعدي^٢

^١ فرع الصحة العامة البيطرية، كلية الطب البيطري، ^٢ فرع العلوم العامة، كلية التربية الأساسية، جامعة الموصل، الموصل، العراق

الخلاصة

تناول البحث التحري عن تواجد الرصاص والكروم والكوبلت في ١٦٠ عينة من لحوم الأبقار والجاموس المحلية والمستوردة باستخدام جهاز قياس طيف الامتصاص الذري. سجلت النتائج ارتفاعا معنويا في معدلات تركيز كل من عنصر الرصاص والكروم ٠,١٣٣ و ٠,٠٦٥١ ملغم/كغم، على التوالي، مقارنة بالكوبلت ٠,٠٠٨ ملغم/كغم في لحوم الأبقار المحلية، وأظهرت النتائج ارتفاعا معنويا في معدل تركيز الرصاص ٠,١٨٢ ملغم/كغم مقارنة بالكروم والكوبلت ٠,٠٤٨٦ و ٠,٠٠٩٧١ ملغم/كغم، على التوالي في لحوم الأبقار المستوردة. سجلت النتائج عدم وجود فروقات معنوية في معدلات تركيز الرصاص والكروم والكوبلت في لحوم الجاموس المحلية ٠,١١٩، ٠,٠٨٩٦ و ٠,٠١٧ ملغم/كغم على التوالي والمستوردة ٠,١٠٦، ٠,١٠٢ و ٠,٠٤١ ملغم/كغم على التوالي. أظهرت النتائج بأن ٢٠% من لحوم الأبقار والجاموس المحلية و ١٢,٥% من لحوم الأبقار المستوردة و ٢٢,٥% من لحوم الجاموس المستوردة قد تجاوزت الحدود العليا المسموح بها للرصاص في اللحوم. بلغت نسبة العينات المتجاوزة للحدود المسموح بها للكروم في اللحوم ٢,٥% من لحوم الأبقار المستوردة و ٥% في كل من لحوم الجاموس المحلية والمستوردة. أخيرا أظهرت النتائج أن جميع عينات لحوم الأبقار والجاموس المحلية والمستوردة تقع ضمن الحدود المسموح بها للكوبلت في اللحوم. تم مناقشة المخاطر المرتبطة بتواجد هذه المعادن في اللحوم على الصحة العامة لمستهلكي هذه اللحوم.

Introduction

Meat is an excellent source of high-quality protein, as it provides all essential amino acids necessary for growth and maintenance of our bodies. It is also a valuable source of many vitamins, minerals and trace elements, specially vitamins B3, B6 and B12, in addition to iron, zinc and selenium (1,2).

Despite of that meat comprises an important part of human diet, but may constitutes a real threat to human health at the same time when polluted with many hazardous chemicals as heavy metals even in very little quantities (3). Heavy metals are permanently liberated to ecosystems, both terrestrial and aquatic, as a consequence of various human activities.

Cattle and buffalo can be subjected to these metals primarily through drinking water and feed (4). Heavy metals contamination of meat constitutes a significant hazard on human health due to their toxicity and bioaccumulation in human diets (5,6).

Lead has no any recognized biological role in the body. It can adversely affect multiple systems of human body, mainly as a result to interference with wide range of enzymes and finally causing serious disorders on central nervous, hepatic, hematopoietic, reproductive, cardiovascular, endocrinal, gastrointestinal and renal systems (7). Both chromium and cobalt are essential trace metals for humans. Excessive intake of these metals exceeding the acceptable limits can cause many severe adverse effects on human health (8).

Contamination of meat and other edible tissues with heavy metals is a matter of great concern for food safety and human health (9). For this reason, investigation metals level in meat and other edible organs obtained from different animal species were conducted in Iraq (10-12).

In addition to the studies conducted worldwide which highlighted the risks originated from presence of these metals in meat and other products of animal origin which occupy a special importance in human food (13-15). Furthermore, the instances of meat products contamination with heavy metals during processing were reported (16).

Due to the urgent need for a local database and risk assessment studies related to the potential threats originating from contamination of human food of animal origin with heavy metals, we offered this study to investigate some of these metals Pb, Cr and Co in local and imported cattle and buffalo meat, that comprise a serious human health hazard, when they above the maximum permissible limits in meat.

Materials and methods

A total of 160 local and imported cattle and buffalo meat samples (40 samples for each) were randomly

obtained from local markets and butcher shops in Mosul city, northern Iraq from February to May 2013. The samples were placed in polyethylene bags and immediately transported to the laboratory under refrigerated conditions. The samples were stored at -18°C until required after removing of gross fat, main blood vessels and connective tissue (17).

Meat samples were triturated and homogenized inconformity with the method described by (18). Each homogenized sample 5 g were wet digested with 35 ml of a mixture of high purity concentrated HNO₃: HClO₄ (6:1 v/v) according to (19). After digestion, slow evaporation for the colorless liquor obtained to near dryness. The residue was cooled and dissolved in 5 mL of nitric acid 20%, then diluted with the deionized water to 25 ml. Lead, chromium and cobalt were measured using Atomic Absorption Spectrophotometer (GBC SensAA).

Laboratory glassware was firstly cleaned with distilled water, drenched for 48 hours in nitric acid 10%, then swilled with deionized water for several times and finally air dried. All the reagents used in this study were of analytical grade. The commercial standards for atomic absorption analysis were used which contained the minerals analyzed in a high pure state. Calibration of the instrument with the standards of studied metals were performed before introducing of the sample digest. A recovery test was achieved by inoculating selected analyzed samples with definite concentrations of studied metals, and the samples were reanalyzed. Each analysis was performed in triplicate.

Statistical analysis was performed depending on Two Way Analysis of Variance procedure of the statistical program, Sigma Stat for windows Version 3.10 (20). Duncan's Multiple Range Test was accomplished for means comparison at P<0.05 (21).

Results

Results related to occurrence of studied metals in local and imported cattle meat samples showed range and mean concentrations of Pb, Cr and Co in local cattle meat 0.016-2.11 (0.136), 0.013-0.92 (0.0651) and 0.002-0.089 (0.008) mg/kg, respectively, whereas Pb and Cr presented the higher significant levels. In imported cattle meat, results reported range and mean concentrations of the aforementioned metals 0.012-2.34 (0.182), 0.004-1.65 (0.0486) and 0.004-0.21 (0.00971 mg/kg), respectively, where Pb showed the higher significant level. No significant differences between local and imported cattle meat in their metals content were reported (Table 1).

Results concerning Pb, Cr and Co levels in local and imported buffalo meat were illustrated in table 2. In local buffalo meat, results showed range and mean concentrations of Pb, Cr and Co 0.01-3.03 (0.119), 0.009-2.03 (0.0896) and 0.002-0.15 (0.017) mg/kg, respectively.

Samples obtained from imported buffalo meat presented Pb, Cr and Co range and mean concentrations of 0.014-2.66 (0.106), 0.016-1.74 (0.102) and 0.003-0.1 (0.041) mg/kg, respectively. Results of statistical analysis showed no significant differences in the mean concentrations of Pb, Cr

and Co within the same meat type local or imported, and between local and imported buffalo meat in their metals content (Table 2). Also, no significant differences between cattle and buffalo meat (local and imported) in their content of studied metals were reported (Table 3 and 4).

Table 1: Range and mean concentrations (mg/kg) of lead, chromium and cobalt in local and imported cattle meat

Meat type	Samples No.	Pb		Cr		Co	
		Range	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE
Local	40	0.016-2.11	0.136±0.0552 a	0.013-0.92	0.0651±0.0244ab	0.002-0.089	0.008±0.0021b
Imported	40	0.012-2.34	0.182±0.0711a	0.004-1.65	0.0486±0.0411b	0.004-0.21	0.00971±0.0051b

Vertically and horizontally different letters are significantly different at P<0.05.

Table 2: Range and mean concentrations (mg/kg) of lead, chromium and cobalt in local and imported buffalo meat

Meat type	Samples No.	Pb		Cr		Co	
		Range	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE
Local	40	0.01-3.03	0.119±0.0752a	0.009-2.03	0.0896±0.0567a	0.002-0.15	0.017±0.0040a
Imported	40	0.014-2.66	0.106±0.0659a	0.016-1.74	0.102±0.0515a	0.003-0.1	0.041±0.0043a

Vertically and horizontally different letters are significantly different at P<0.05.

Table 3: Comparison between local cattle and buffalo meat in their contents of lead, chromium and cobalt

Animal species	Mean ± SE (mg/kg)		
	Pb	Cr	Co
Cattle	0.136 ± 0.0552 a	0.0651 ± 0.0244 a	0.008 ± 0.00212 a
Buffalo	0.119 ± 0.0752 a	0.0896 ± 0.0567 a	0.017 ± 0.00404 a

Vertically similar letters are not significantly different at P<0.05.

Distribution of Pb in 160 samples of local and imported cattle and buffalo meat (40 samples for each) (Figure 1). Eight samples from each local cattle and buffalo meat 20% were exceeded the maximum acceptable limit proposed by European Union (EU) for lead in meat 0.1 mg/kg. Also, five samples of imported cattle meat 12.5% and nine samples of imported buffalo meat 22.5% were higher than the permissible limit.

Concerning Cr, samples exceeded the maximum allowable limit for Cr (Figure 2), which reported that from 40 samples of each meat type, only one sample of imported cattle meat 2.5% and 2 samples from each of local and imported buffalo meat 5% were exceeded the maximum permissible limit for Cr in meat as proposed by the United States Department of Agriculture (USDA) 1 mg/kg.

Finally, results recorded that all samples of cattle and buffalo meat (local and imported) were within the maximum acceptable limits for Co according to Food and

Agriculture Organization/ World Health Organization (FAO/WHO) 1mg/kg. (Figure 3).

Table 4: Comparison between imported cattle and buffalo meat in their contents of lead, chromium and cobalt

Animal species	Mean ± SE (mg/kg)		
	Pb	Cr	Co
Cattle	0.182 ± 0.0711 a	0.0486 ± 0.0411 a	0.00971 ± 0.00514 a
Buffalo	0.106 ± 0.0659 a	0.102 ± 0.0515 a	0.041 ± 0.00431 a

Vertically similar letters are not significantly different at P<0.05.

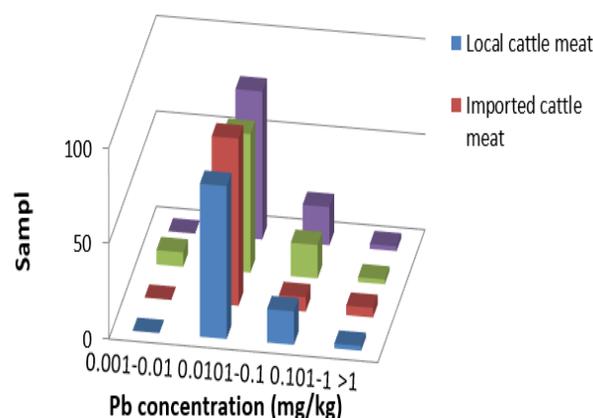


Figure 1: Occurrence of Pb (mg/kg) in cattle and buffalo meat

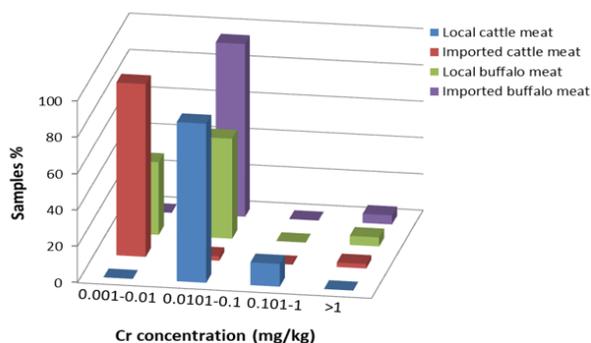


Figure 2: Occurrence of Cr (mg/kg) in in cattle and buffalo meat

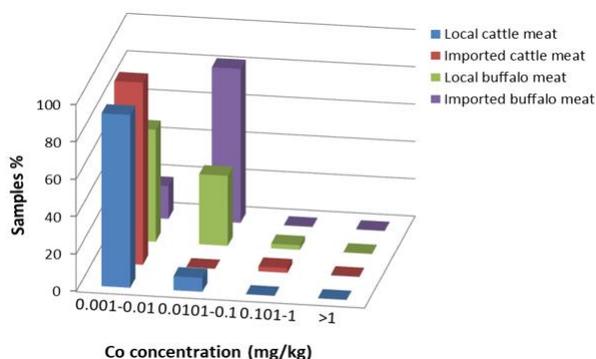


Figure 3: Occurrence of Co (mg/kg) in in cattle and buffalo meat

Discussion

Heavy metals residues have acquired particular concern due to these metals cannot be disintegrated and exist permanently in the environment (22). For this reason, contamination of human food with these metals at toxic levels is certainly constitutes a serious problem for human health.

Results reported that Pb presented the higher levels, then Cr whereas Co showed the lowest levels in both local and imported meat of cattle and buffalo. These results were in agreement with the results of the study reported by Abd EI-Salam and coworkers (23), which revealed that Pb, Cr and Co levels in cattle and buffalo meat were 2.7, 0.3 and 0.138 and 3.25, 0.488 and 0.05 mg/kg, respectively. Also, results were accommodating with the results recorded by Nkansah and Ansah (14) which stated that Pb was presented in meat at levels 0.237 - 1.154 mg/kg higher than that for Cr 0.0472 - 0.957 mg/kg. On the other hand, results were in contrast with the results offered by Yakup and colleagues (12) who showed that Pb was detected in cattle

and buffalo meat at concentrations 0.702 and 0 mg/kg, respectively lower than those found for Co 1.042 and 0.497 mg/kg, respectively.

These variations in Pb, Cr and Co levels in meat were attributed to several factors including dietary habits, water and feed sources, place and age of animals, butcher shop place, meat origin, conditions of meat transportation and offering, in addition to other environmental conditions (13). No significant differences between meat of cattle and buffalo (local and imported) in their content of Pb, Cr and Co were recorded. Our study was in coincide with the studies mentioned by (24,25) which revealed that Pb concentrations in cow's and buffalo's meat was not significantly different. Results were incompatible with (23) who showed significant differences between cattle and buffalo meat in their metals content of Pb, Cr and Co.

Conclusion

Our study exposed substantial information about Pb, Cr and Co levels in local and imported cattle and buffalo meat. Although all meat samples were within the maximum permissible limits for Co, but special attention should be focused about Pb and Cr levels in meat as they present at levels higher than the tolerable limits in some meat samples. Strict legislations should be adopted concerning heavy metals levels in meat and other foodstuffs in order to provide safe products to the consumers.

Acknowledgments

Authors wish to thank the College of Veterinary Medicine, University of Mosul for support and providing facilities. Appreciation is also extended to the Department of General Science, College of Basic Education, University of Mosul for samples analysis with atomic absorption spectrophotometer.

Conflict of interest

The authors certify that they have no conflict of interest.

References

- Williams P. Nutritional composition of red meat. *Nutrition & Dietetics*. Wiley. 2007; 64(4): 113–119. [10.1111/j.1747-0080.2007.00197.x](https://doi.org/10.1111/j.1747-0080.2007.00197.x)
- Ahmad RS, Imran A, Hussain MB. Nutritional Composition of Meat. *Meat Science and Nutrition*. In Tech. 2018. [10.5772/intechopen.77045](https://doi.org/10.5772/intechopen.77045)
- Demirezen D, Uruç K. Comparative study of trace elements in certain fish, meat and meat products. *Meat Science*. Elsevier BV. 2006; 74(2): 255–60. [10.1016/j.meatsci.2006.03.012](https://doi.org/10.1016/j.meatsci.2006.03.012)
- Montoro R, Vélez D. Detecting metal contamination. In: Watson DH. ed. *Pesticide, Veterinary and Other Residues in Food*. Elsevier. 2004; 610–40. [10.1533/9781855739109.4.610](https://doi.org/10.1533/9781855739109.4.610)

5. Goyer RA, Clarkson TW. Toxic effects of metals. In: Klaassen CD. ed. Casarett and Doull's Toxicology: The basic science of poisons. 6th ed., McGraw-Hill companies, Inc., USA. 2001: 861-867. [https://www.scrip.org/\(S\(vtj3fa45qm1ean45vffcz55\)\)/reference/ReferencesPapers.aspx?ReferenceID=1883135](https://www.scrip.org/(S(vtj3fa45qm1ean45vffcz55))/reference/ReferencesPapers.aspx?ReferenceID=1883135)
6. Hajeb P, Sloth JJ, Shakibazadeh S, Mahyudin NA, Afsah-Hejri L. Toxic Elements in Food: Occurrence, Binding, and Reduction Approaches. *Comprehensive Reviews in Food Science and Food Safety*. Wiley. 2014; 13(4):457-72. [10.1111/1541-4337.12068](https://doi.org/10.1111/1541-4337.12068)
7. Flora G, Gupta D, Tiwari A. Toxicity of lead: a review with recent updates. *Interdisciplinary Toxicology*. Walter de Gruyter GmbH. 2012; 5(2):47-58. [10.2478/v10102-012-0009-2](https://doi.org/10.2478/v10102-012-0009-2)
8. Zahran AD, Hendy BA. Heavy metals and trace elements composition in certain meat and meat products sold in Egyptian markets. *Internat J Sci: Basic Appl Res. IJSBAR*. 2015; 20(1): 282-293. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.676.4699&rep=rep1&type=pdf>
9. Santhi D, Balakrishnan V, Kalaikannan A, Radhakrishnan KT. Presence of heavy metals in pork products in Chennai (India). *Am J Food Technol*. 2008; 3(3): 192-199. [10.ajft.2008.192.199](https://doi.org/10.ajft.2008.192.199)
10. Al-Naemi HS. Estimation of lead and cadmium levels in muscles, livers and kidneys of slaughtered cattle in Mosul city. *Mesopotamia J Agric*. 2011; 39(3):8-16. [10.33899/magrj.2011.31125](https://doi.org/10.33899/magrj.2011.31125)
11. Al-Zuhairi WS, Farhan MA, Ahmed MA. Determine of heavy metals in the heart, kidney and meat of beef, mutton and chicken from Baquba and Howaydir market in Baquba, Diyala Province, Iraq. *Internat J Recent Sci Res*. 2015; 6 (8): 5965-5967. <http://www.recentscientific.com>
12. Yakup NY, Sabow AB, Saleha SJ, Mohammed GR. Assessment of heavy metal in imported red meat available in the markets of Erbil City. *J University Babylon, Pure and Applied Sci*. 2018; 26 (6): 177-183. <https://www.journalofbabylon.com/index.php/JUBPAS/article/view/1469>
13. Chowdhury MZA, Siddique ZA, Hossain SA, Kazi AI, Ahsan AA, Ahmed S, Zaman MM. Determination of essential and toxic metals in meats, meat products and eggs by spectrophotometric method. *J Bangladesh Chem Society*. 1970; 24(2):165-172. [10.3329/jbcs.v24i2.9705](https://doi.org/10.3329/jbcs.v24i2.9705)
14. Nkansah MA, Ansah JK. Determination of Cd, Hg, As, Cr and Pb level in meat from the Kumasi central abattoir. *Internat J Sci Res Publications*. 2014; 4 (8): 1-4. <http://ijsrp.org/>
15. Nawaz R, Ur Rehman S, Nawaz S, Iftikhar B. Analysis of heavy metals in red meat in District Peshawar Khyber Pakhtunkhwa. *J Med Sci*. 2015; 23(3): 166-171. <https://pdfs.semanticscholar.org/f9e4/cdeb29404c5318d35f453f5b243553980f46.pdf>
16. Brito G, Díaz C, Galindo L, Hardisson A, Santiago D, García Montelongo F. Levels of metals in canned meat products: Intermetallic correlations. *Bulletin of Environmental Contamination and Toxicology*. Springer Science and Business Media LLC. 1990; 44(2):309-16. [10.1007/bf01700152](https://doi.org/10.1007/bf01700152)
17. Lopez Alonso M, Benedito JL, Miranda M, Castillo C, Hernandez J, Shore RF. Toxic and trace elements in liver, kidney and meat from cattle slaughtered in Galicia (NW Spain). *Food Addit Contam. Informa UK Limited*. 2000; 17(6):447-57. [10.1080/02652030050034028](https://doi.org/10.1080/02652030050034028)
18. Al-Baggou' BK. Neurobehavioral and biochemical changes induced by interaction between cadmium and some insecticides in mice. [PhD Dissertation]. Mosul: Mosul University, 2002. 35 p.
19. Iwegbue CM. Heavy metal composition of livers and kidneys of cattle from southern Nigeria. *Vet Arhiv*. 2008; 78 (5): 401-410. <https://hrcak.srce.hr/28916>
20. Steel RG, Torrie JH. Principles and procedures of statistics. (with special reference to the biological sciences). McGraw- Hill Book Company, New York, Toronto, London. 1960. [10.1002/bimj.19620040313](https://doi.org/10.1002/bimj.19620040313)
21. Duncan DB. Multiple Range and Multiple F Tests. *Biometrics*. JSTOR. 1955;11(1):1. [10.2307/3001478](https://doi.org/10.2307/3001478)
22. Baykov BD, Stoyanov MP, Gugova ML. Cadmium and lead bioaccumulation in male chickens for high food concentrations. *Toxicol Environ Chem. Informa UK Limited*. 1996; 54(1-4): 155-9. [10.1080/02772249609358308](https://doi.org/10.1080/02772249609358308)
23. Abd El-Salam NM, Ahmad S, Basir A, Rais AK, Bibi A, Ullah R, Shad AA, Muhammad Z, Hussain I. Distribution of heavy metals in the liver, kidney, heart, pancreas and meat of cow, buffalo, goat, sheep and chicken from Kohat market Pakistan. *Life Sci J*. 2013; 10(7s): 937-940. <http://www.lifesciencesite.com/>
24. Khalafalla FA, Abdel-Atty NS, Abd-El-Wahab MA, Ali OI, Abo-El-soud RB. Assessment of heavy metal residues in retail meat and offals. *J Am Sci*. 2015; 11(5): 50-54. <http://www.jofamericanscience.org/>
25. Gulsanga G, Anjum Z, Alam S, Shehzad F. Heavy Metals and Mineral Contents of Beef Sold at University Campus, Peshawar, Khyber Pakhtunkhwa, Pakistan. *Sarhad J Agric. Researchers Links Ltd*. 2018; 34(2):471-477. [10.17582/journal.sja/2018/34.2.471.477](https://doi.org/10.17582/journal.sja/2018/34.2.471.477)